

some 4000 or 5000 feet into the mountains, when, in these latitudes at least, the reflecting surface must necessarily be snow.

In the above remarks I have confined myself strictly to the physical aspect of the subject; but it is obvious that, in seeking an alpine sanitarium, the patient comes under new conditions of respiration, and breathes air comparatively free from zymotic matter—circumstances which are probably not without profound influence upon his health.

III. Addition to the Paper, “Volcanic Energy: an attempt to develop its true Origin and Cosmical Relations”*. By ROBERT MALLET, A.M., C.E., F.R.S., M.R.I.A., &c. Received April 3, 1874.

(Abstract.)

Referring to his original paper (Phil. Trans. 1873), the author remarks here that, upon the basis of the heat annually dissipated from our globe being equal to that evolved by the melting of 777 cubic miles of ice at zero to water at the same temperature, and of the experimental data contained in his paper, he had demonstrated, in terms of mean crushed rock, the annual supply of heat derivable from the transformation of the mechanical work of contraction available for volcanic energy, and had also estimated the proportion of that amount of heat necessary to support the annual vulcanicity now active on our globe; but, from the want of necessary data, he had refrained from making any calculation as to what amount in volume of the solid shell of our earth *must* be crushed annually, in order to admit of the shell following down after the more rapidly contracting nucleus. This calculation he now makes upon the basis of certain allowable suppositions, where the want of data requires such to be made, and for assumed thicknesses of solid shell of 100, 200, 400, and 800 miles respectively.

From the curve of total contraction (plate x. Phil. Trans. part i. 1873) obtained by his experiments on the contraction of slags, he has now deduced partial mean coefficients of contraction for a reduction in temperature of 1° Fahr., for intervals generally of about 500° for the entire scale, between a temperature somewhat exceeding that of the blast-furnace and that of the atmosphere, or 53° Fahr. And applying the higher of these coefficients to the data of his former paper, and to the suppositions of the present, he has obtained the absolute contraction in volume of the nuclei appertaining to the respective thicknesses of solid shell above stated. In order that the shell may follow down and remain in contact with the contracted nucleus, either its thickness must be in-

* Read June 20, 1872; Phil. Trans. for 1873, p. 147.

creased, its volume remaining constant, or the thickness being constant, a portion of the volume must be extruded. The former supposition is not admissible, as the epoch of mountain-building has apparently ceased; adopting the second, the author calculates the volume of matter that must be crushed and extruded from the shell in order that it may remain in contact with the nucleus. He tabulates these results for the four assumed thicknesses of shell, and shows that the amount of crushed and extruded rock necessary for the heat for the support of existing volcanic action is supplied by that extruded from the shell of between 600 and 800 miles thickness, and that the volume of material, heated or molten, annually blown out from all existing volcanic cones, as estimated in his former paper, could be supplied by the extruded matter from a shell of between 200 and 400 miles in thickness.

On data which seem tolerably reliable the author has further been enabled to calculate, as he believes for the first time, the actual amount of annual contraction of our globe, and to show that if that be assumed constant for the last 5000 years, it would amount to a little more than a reduction of about 3·5 inches on the earth's mean radius. This quantity, mighty as are the effects it produces as the efficient cause of volcanic action, is thus shown to be so small as to elude all direct astronomical observation, and, when viewed in reference to the increase of density due to refrigeration of the material of the shell, to be incapable of producing, during the last 2000 years, any sensible effect upon the length of the day. The author draws various other conclusions, showing the support given by the principal results of this entirely independent investigation to the verisimilitude of the views contained in his previous memoir.

Presents received, April 16, 1874.

Transactions.

- Batavia :—Koninklijke Natuurkundige Vereeniging in Nederlandsch Indie. *Natuurkundig Tijdschrift voor Nederlandsch Indie*. Deel XXXII. Afl. 4–6. 8vo. 1873. The Society.
- Danzig :—Naturforschende Gesellschaft. *Schriften. Neue Folge*. Band III. Heft 2. 8vo. 1873. (Another copy, with photographs.) The Society.
- Göteborg :—Kongl. Vetenskaps och Vitterhets Samhälle. *Handlingar*. Ny Tidsföljd. 12 Häftet. 8vo. 1873. The Society.
- Harlem :—Société Hollandaise des Sciences. *Archives Néerlandaises des Sciences Exactes et Naturelles*. Tome VIII. Liv. 3, 4. 8vo. *La Haye* 1873. The Society.